Outlook for 2010 September Arctic Sea Ice Extent Minimum
June Report based on May Data

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In Spring, 2010, NIC acquired the Arctic Region Ice Forecast System (ARIFS, Drobot et al. 200x) from the University of Colorado, with a view toward implementing the system operationally for weekly to seasonal support of Navy, Coast Guard, and other maritime clients. This code employs a multi-linear regression system to correlate the conditions of week X (the predictor week) with the conditions of week Y (the predicted week). In this case, we use NCEP 2 meter Air Temperatures, NCEP Sea Level Pressure, and Ice Extent from the NASA Team algorithm as predictors, with Sea Ice Extent as the predicand. The past 10 years of data (2000-2009) are correlated to determine a series of correlations between Week X and Week Y for each predictor, and this is passed through a multilinear regression to arrive at a predition for Week Y. All data are on the NSIDC EASE (equal area scalable earth) grid, so comparisons with the NSIDC Sea Index (considered "truth" in the SEARCH Sea Ice Outlook) are straightforward. While the color on the charts follow the World Meteorological Organization color codes for sea ice concentration, we only include ice of greater than 15% concentration per 25 km^2 grid cell, allowing a direct comparison with the NSIDC Sea Ice Index. The extent is the sum of the areas of the grid cells containing at least 15% ice coverage. This is different than the concentration, which is the sum of all ice covered area, and will always be less than the extent. The "donut hole" in the middle of the ice is due to the blind spot on the SSM/I sensor. No predictions are made in this area as there are no ice measurements. Replacement or supplementation with digitized NIC ice charts may solve this problem in future outlooks.

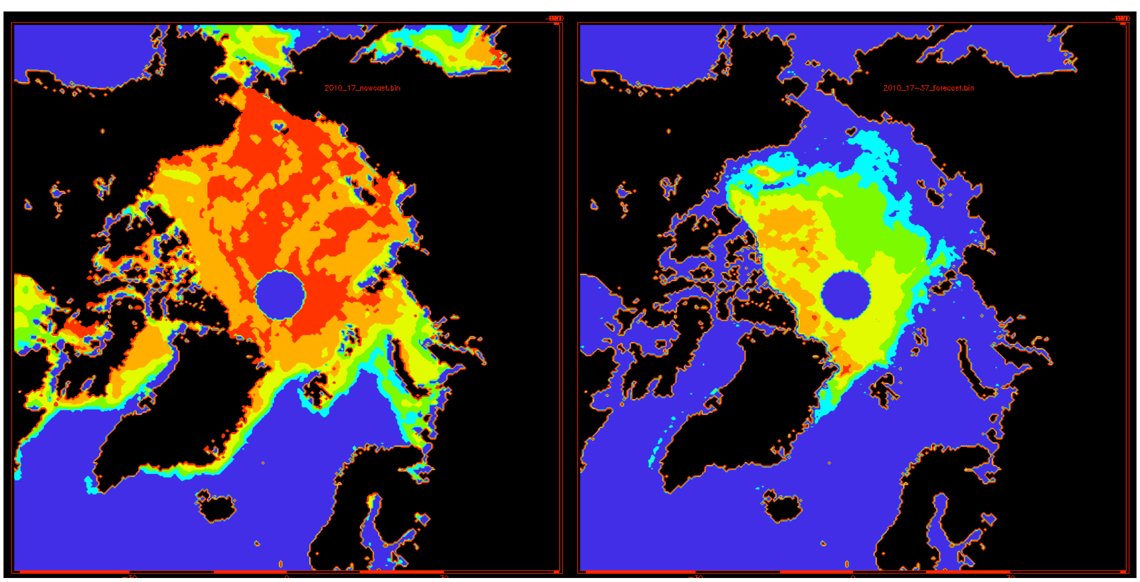


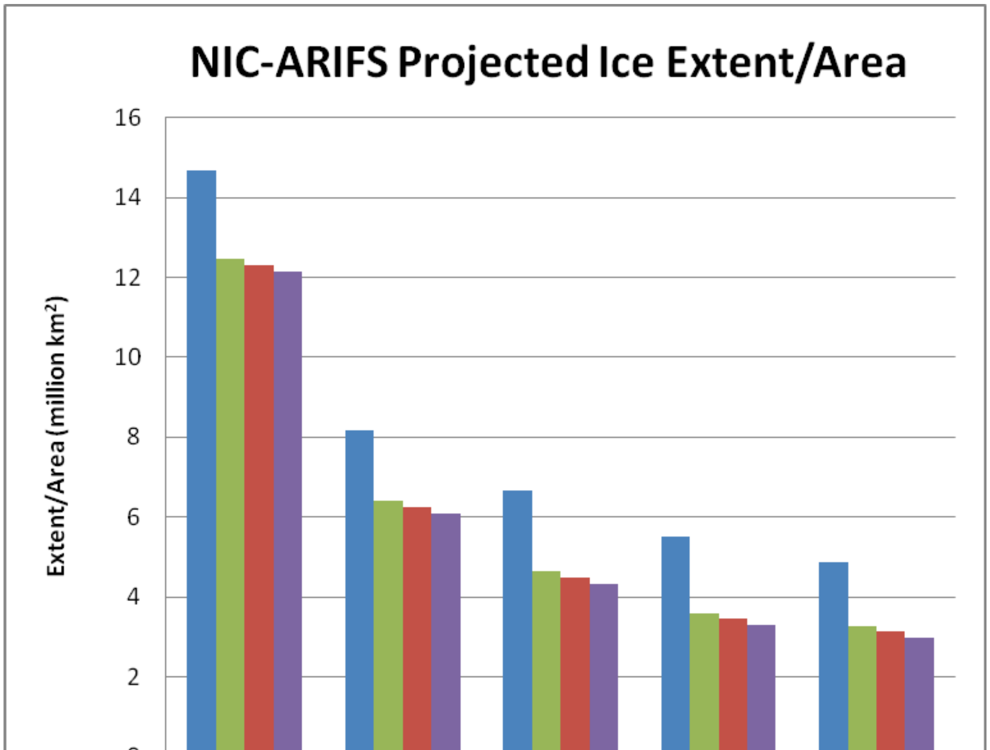
Figure 1: Sea ice extent and concentration for 2010, end of April conditions (left) and projected conditions for 2010, mid-September conditions (right). The blue area in the center (surrounding the North Pole) is the SSM/I blind spot; no projections are done for this region. WMO color codes are given in Figure 2.

Figure 2: WMO Sea Ice Color codes for Ice Concentration.

The current and projected conditions for 2010 are shown in figure 1. Despite the reasonably large current extent (14.665 million km2 and compact concentration (12.461 million km2) in late April, the projected extent for mid-September is another near-record low (4.852 million km^2), while the actual ice-covered area could be 3.123 million km^2. As indicated in by the WMO Sea Ice Concentration legend (Figure 2), the most compact ice is on the Canadian side of the Arctic Ocean, while the pack on the Siberian side is diffuse (1-3/10th concentration). While no information is known about the blind spot in the center of the figures, it is assumed that there will be ice present and therefore the area of the circle is included in the calculations of ice extent and ice area (detailed below). The projection suggests an open and navigable Northern Sea Route at the September Minimum. At this point, ARIFS is not configured to compute ice conditions within the Canadian Archipelago, so no statement can be made about the Northwest Passage, and its area is not figured into the total extent and ice area of the Arctic. Thus there is a potential low bias in concentration and extent.

Figure 3 shows the progression of Ice Extent and Ice Area from the Nowcast (Week 17) through 4 forecast weeks (25, 29, 33, 37) corresponding to June 20, July 18, August 15, and September 12, 2010. Again, the ice extent is the largest number, while now there is a range of values for ice area, assuming 100%, 50%, and 0% ice coverage in the blind spot. For the nowcast, it is most likely that the ice-covered area is near 100%; based on the surrounding area, it is assumed that the ice-covered area in the circle at September 12 is around 50%.

Future work will quantify the variability and error statistics of the input fields (ice area, surface air temperature, and sea level pressure) and compute new projections based on end-of-June conditions.



	17	25	29	33	37
Extent	14.665	8.18	6.65938	5.52313	4.8525
Area_h	12.4614	6.40288	4.64406	3.59574	3.27892
Area	12.3054	6.24726	4.48843	3.44012	3.12267
Area_l	12.1495	6.09163	4.33281	3.28449	2.96642

Figure 3: Projected Arctic Sea Ice Extent and Area over summer 2010, based on Week 17 conditions. The range of areas is bsased on the assumption of 100%, 50%, and 0% concentration within the blind spot of the SSM/I sensor.

The NIC also generated a simple linear regression model (Helfrich and Arbetter Regression Model) based on the past ten years of data. While the sample size is significantly low, F-test statistics (Sig F = .03) suggest that a proposed regression model fits the data well even proving the small sample size. Correlation coefficients suggested a high level of correlation between the regression model and past observations (R^2 = .927). Independent variables considered for this model include, multiyear ice concentration for May, zonal and meridional winds over the Arctic in March, Northern Hemispheric snow extent for April, and average sea ice area for April, air temperatures in April. Each was found to be correlated with the September minimum ice extent. The forecasted 2010 minima from this model suggests 5.14 million km^2 for ice extent. We will continue to track differences between the NIC ARIFS prediction and the Helfrich and Arbetter Regression Model.

(CAVEAT: This is not an official National Ice Center forecast and should not be interpreted as advice for navigation. Only ice-capable ships with experienced ice pilots should attempt navigation in the Arctic, and should consult with local authorities for current ice conditions and navigational restrictions.)

References

Drobot, S. D., J. A. Maslanik, and M. R. Anderson, 2008: Interannual variations in the opening date of the Prudhoe Bay shipping season: links to atmospheric and surface conditions. *International Journal of Climatology*, **29** (2), 197-203.